Dynamic interplay of biogeochemical carbon, sulfur, and barium cycles during the largest carbon isotope negative excursion in Earth history

Huan Cui
Department of Geology, Kansas State University, Manhattan, KS 66506, USA

Compared with Phanerozoic strata, sulfate minerals are relatively rare in the Precambrian record likely due to the lower concentrations of sulfate in dominantly anoxic oceans. Here, we present a compilation of sulfate minerals that are stratigraphically associated with the Ediacaran Shuram excursion — the largest carbon isotope negative excursion in Earth history. We evaluated 15 sections globally, all of which reveal the presence of sulfate minerals and/or concentration enrichment in carbonate-associated sulfate, suggesting a rise in sulfate reservoir. Notably, where data are available, sections of the Shuram excursion also reveal considerable enrichments in barium relative to pre- and post-excursion intervals. We propose that elevated seawater sulfate concentrations during the Shuram excursion may have facilitated authigenesis of sulfate minerals. At the same time, the rise of barium concentrations in shelf environments further facilitated barite deposition. A larger sulfate reservoir would stimulate microbial sulfate reduction and anaerobic oxidation of organic matter (including methane), contributing to the genesis of the Shuram excursion. The existence of sulfate minerals throughout the Shuram excursion suggests that oxidant pools were not depleted at that time, which challenges previous modelling results. Our study highlights the dynamic interplay of biogeochemical carbon, sulfur, and barium cycles in response to the profound oxygenation event at that time.